

WE CLAIM:

1. A method of treating and drying the surface of an object, comprising the steps of:
 - (a) providing a vessel and at least one object having a surface;
 - (b) immersing the object in a process fluid in the vessel;
 - (c) discharging the process fluid from the vessel, leaving residual process fluid on the surface of the object;
 - (d) after discharging the process fluid from the vessel, introducing a drying vapor into the vessel, the drying vapor condensing on the surface of the object and reducing the surface tension of the residual process fluid, causing the residual process fluid to flow off of the surface.
2. The method of claim 1 wherein the process fluid is deionized water.
3. The method of claim 1 wherein the process fluid is hydrofluoric acid.
4. The method of claim 1, further including the step of introducing a heated gas into the vessel after step (d) to volatilize condensed drying vapor from the surface.
5. The method of claim 1, wherein
the method further includes the step of, prior to step (b), generating the drying vapor at a location remote from the vessel; and
step (d) includes the step of using a carrier gas to carry the drying vapor from the remote location into the vessel.

6. The method of claim 5 wherein:

step (a) further provides a chamber fluidly coupled to the vessel, the chamber positioned remotely from the vessel;

the generating step includes the step of heating a drying compound within the chamber to produce the drying vapor; and

step (d) includes passing the carrier gas through the chamber to cause it to carry the drying vapor into the vessel.

7. The method of claim 1, wherein the method further includes the step of reclaiming drying vapor from the vessel and condensing the reclaimed drying vapor to a liquid form.

8. The method of claim 1 wherein the drying vapor is formed from isopropyl alcohol.

9. A method of treating and drying the surface of an object, comprising the steps of:

(a) providing a vessel and at least one object having a surface;

(b) immersing the object in a liquid chemical within the vessel to treat the object;

(c) introducing a rinse fluid into the vessel to rinse the chemical from the vessel and from the surface of the object;

(e) discharging the rinse fluid from the vessel, leaving residual rinse fluid on the surface of the object;

(f) after discharging the rinse fluid from the vessel, introducing a drying vapor into the vessel, the drying vapor condensing on the surface of the object and reducing the surface tension of the residual rinse fluid, causing the residual rinse fluid to flow off of the surfaces.

10. The method of claim 9 further including the step of introducing a heated gas into the vessel after step (d) to volatilize condensed drying vapor from the surface.

11. The method of claim 9, wherein

the method further includes the step of, prior to step (b), generating the drying vapor at a location remote from the vessel; and

step (d) includes the step of using a carrier gas to carry the drying vapor from the remote location into the vessel.

12. The method of claim 11 wherein

step (a) further provides a chamber fluidly coupled to the vessel, the chamber positioned remotely from the vessel;

the generating step includes the step of heating a drying compound within the chamber to produce the drying vapor; and

step (d) includes passing the carrier gas through the chamber to cause it to carry the drying vapor into the vessel.

13. The method of claim 9, wherein the method further includes the step of reclaiming drying vapor from the vessel and condensing the reclaimed drying vapor to a liquid form.

14. The method of claim 9 wherein the drying vapor is formed from isopropyl alcohol.

15. The method of claim 9 wherein the rinse fluid is deionized water.
16. The method of claim 9 wherein the method includes the step of rinsing the objects in ozonated water.
17. The method of claim 16, including the step of rinsing the object with ozonated rinse fluid prior to step (d).
18. A method of treating and drying the surface of an object, comprising the steps of:
 - (a) providing a vessel, a remote chamber fluidly coupled to but remote from the vessel, and at least one object having a surface;
 - (b) treating the object using a wet processing procedure outside the vessel, to produce a wet object having residual process fluid thereon;
 - (c) positioning the wet object in the vessel;
 - (d) generating a drying vapor in the chamber; and
 - (e) passing a carrier gas through the chamber into the vessel, the carrier gas carrying the drying vapor from the chamber into the vessel, the drying vapor condensing on the surface of the object and reducing the surface tension of the residual process fluid, causing the residual process fluid to flow off of the surface.
19. The method of claim 18 wherein step (d) includes heating a drying compound within the chamber to produce the drying vapor.

20. The method of claim 19 wherein the drying compound is heated to a temperature below its boiling point.

21. The method of claim 18, wherein:

step (a) further provides a lid for the vessel, the lid including at least one inlet; the method further includes the step of sealing the vessel using the lid; and in step (e) the carrier gas and drying vapor are passed into the vessel via the at least one inlet in the lid.

22. The method of claim 19 wherein the drying compound is isopropyl alcohol.

23. The method of claim 18, wherein the method further includes the step of reclaiming drying vapor from the vessel and condensing the reclaimed drying vapor to a liquid form.

24. The method of claim 18, further including the step of introducing a heated gas into the vessel after step (e) to volatilize condensed drying vapor from the surface.

25. A method of treating and drying the surfaces of an object, comprising the steps of:

- (a) providing a vessel and at least one object having a surface;
- (b) immersing the object in a treatment solution in the vessel, the treatment solution including hydrofluoric acid;
- (c) discharging the treatment solution from the vessel;

(d) after the treatment solution has been fully discharged from the vessel and without first rinsing the object, introducing a drying vapor into the vessel, the drying vapor condensing on the surface of the object and reducing the surface tension of the residual treatment solution causing the residual treatment solution to flow off of the surfaces.

26. The method of claim 25, further including the step of introducing a heated gas into the vessel after step (d) to volatilize condensed drying vapor from the surface.

27. The method of claim 25, wherein:

the method further includes the step of, prior to step (b), generating the drying vapor at a location remote from the vessel; and
step (d) includes the step of using a carrier gas to carry the drying vapor from the remote location into the vessel.

28. The method of claim 27 wherein

step (a) further provides a chamber fluidly coupled to the vessel, the chamber positioned remotely from the vessel;
the generating step includes the step of heating a drying compound within the chamber to produce the drying vapor, and wherein step (d) includes passing the carrier gas through the chamber to cause it to carry the drying vapor into the vessel.

29. The method of claim 28, wherein the method further includes the step of reclaiming drying vapor from the vessel and condensing the reclaimed drying vapor to a liquid form.

30. The method of claim 25 wherein the drying vapor is formed from isopropyl alcohol.

31. The method of claim 25 wherein:

step (a) further provides a lid for the vessel, the lid including at least one inlet; the method further includes the step of sealing the vessel using the lid; and in step (d) the carrier gas and drying vapor are passed into the vessel via the at least one inlet in the lid.

32. A method of treating and drying an object, comprising the steps of:

- (a) providing a vessel having a moveable lid, the lid formed of a plurality of walls joined together to form a bottomless enclosure, and further providing an object having a surface;
- (b) immersing the object in a process fluid in the vessel;
- (c) sealing the vessel using the lid;
- (d) heating at least a portion of the lid to a temperature above that of the process fluid;
- (e) discharging the process fluid from the vessel, leaving residual process fluid on the surface of the object; and
- (f) after the process fluid has been fully discharged from the vessel, introducing a drying vapor into the vessel, the drying vapor condensing on the surface of the object and reducing the surface tension of the residual process fluid, causing the residual process fluid to flow off of the surface.

33. The method of claim 32, wherein the process fluid is rinse fluid and wherein the method further comprises the steps of:

prior to step (b) suspending the lid above the vessel, immersing the object in a chemical bath in the vessel, then discharging the chemical from the vessel after immersing the object, and then sealing the vessel using the lid.

34. The method of claim 33 wherein the step of suspending the lid above the vessel creates a hood above the vessel for minimizing escape of fumes from the vessel into the surrounding atmosphere.

35. The method of claim 32 wherein the lid is provided to have at least one inlet, and wherein step (f) includes introducing the drying vapor into the vessel via the inlet in the lid.

36. The method of claim 32, further including the step of introducing a purging gas into the vessel prior to introducing the drying vapor.

37. The method of claim 31, further including the step of introducing a heated gas into the vessel after step (f) to volatilize condensed drying vapor from the surface of the object.

38. An apparatus for treating and drying an object, the apparatus comprising:
a vessel, the vessel including
an open top portion and a lid moveable between a closed condition
sealing the open top portion and an opened condition leaving the open top
portion exposed,
a dump opening formed in a lower portion of the vessel and a dump door
moveable between an opened condition permitting discharge of fluid through
the dump opening and a closed condition sealing the dump opening, and

a fluid inlet formed in a lower portion of the vessel;
a source of rinse fluid fluidly coupled to the inlet by a fluid line;
a source of process chemical fluidly coupled to the fluid line;
a drying vapor generation chamber fluidly coupled to the vessel; and
a condenser fluidly coupled to the dump opening.

39. The apparatus of claim 38 further comprising:

control means for causing the vessel to be filled with rinse fluid from the source of rinse fluid, for opening the dump door after a predetermined period of time has lapsed following filling of the vessel with the rinse fluid, and for causing the vessel to be filled with drying vapor from the drying vapor generation chamber after the rinse fluid has been discharged from the vessel.

40. The apparatus of claim 39 wherein:

the lid includes a plurality of fluid manifolds formed therein and a plurality of vapor inlets fluidly coupled to the fluid manifolds; and
the drying vapor generation chamber is fluidly coupled to the fluid manifolds.

41. The apparatus of claim 38 wherein:

the drying generation chamber includes:
an enclosed chamber, a heated surface within the chamber for receiving a liquid drying compound to create a drying vapor; and
the apparatus further comprises a carrier gas source fluidly coupled to the enclosed chamber.

42. The apparatus of claim 41 wherein:

the lid includes a plurality of fluid manifolds formed therein and a plurality of vapor inlets fluidly coupled to the fluid manifolds; and

the drying vapor generation chamber is fluidly coupled to the fluid manifolds.

43. The apparatus of claim 38 wherein the source of chemical includes:

a chemical storage tank fluidly coupled to a bulk chemical supply and proportioned to contain a first volume of chemical;
a dispense tank fluidly coupled to the chemical storage tank, the dispense tank proportioned to contain a second volume of chemical significantly smaller than the first volume of chemical;
a first valve between the chemical storage tank and the dispense tank;
a second valve between the dispense tank and the vessel; and
control means for opening the first valve for a predetermined period of time to dispense a predetermined quantity of chemical from the storage tank to the dispense tank, the predetermined quantity corresponding to an amount needed to carry out a process in the vessel, and further for opening the second valve to dispense the predetermined quantity from the dispense tank into the vessel.

44. The apparatus of claim 43 further including a secondary fluid source fluidly coupled to the dispense tank, and a third valve positioned between the secondary fluid source and the dispense tank, the control means being further for controlling operation of the third valve to permit a secondary fluid to mix with the predetermined quantity of chemical to form a process solution.

45. An apparatus for drying an object comprising:

a vessel having an opening;
a lid formed of a plurality of walls joined together to form a bottomless enclosure, the lid moveable between a first position sealing the opening in the vessel and a second position permitting access to the vessel via the opening;
a heating element coupled to the walls of the lid; and

a source of drying vapor fluidly coupled to the vessel.

46. The apparatus of claim 45, wherein the vessel includes an inlet, and wherein the apparatus further comprises a source of rinse fluid fluidly coupled to the inlet.

47. The apparatus of claim 46, further comprising a source of process chemical fluidly coupled to the inlet.

48. The apparatus of claim 46 wherein the vessel further includes a dump opening formed in a lower portion of the vessel and a dump door moveable between an opened condition permitting discharge of fluid through the dump opening and a closed condition sealing the dump opening.

49. The apparatus of claim 46 wherein the lid includes a drying vapor inlet and wherein the source of drying vapor is fluidly coupled to the drying vapor inlet.

50. The apparatus of claim 46 wherein the source of drying vapor includes:
an enclosed chamber having a heated surface for receiving a liquid drying compound, the chamber remote from but fluidly coupled to the vessel; and
a source of carrier gas fluidly coupled to the enclosed chamber.